Volume 72 No 12
December 2004

Amateur Radio

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The magazine for AUSTRALIAN radio amateurs

64 page HOLIDAY issue

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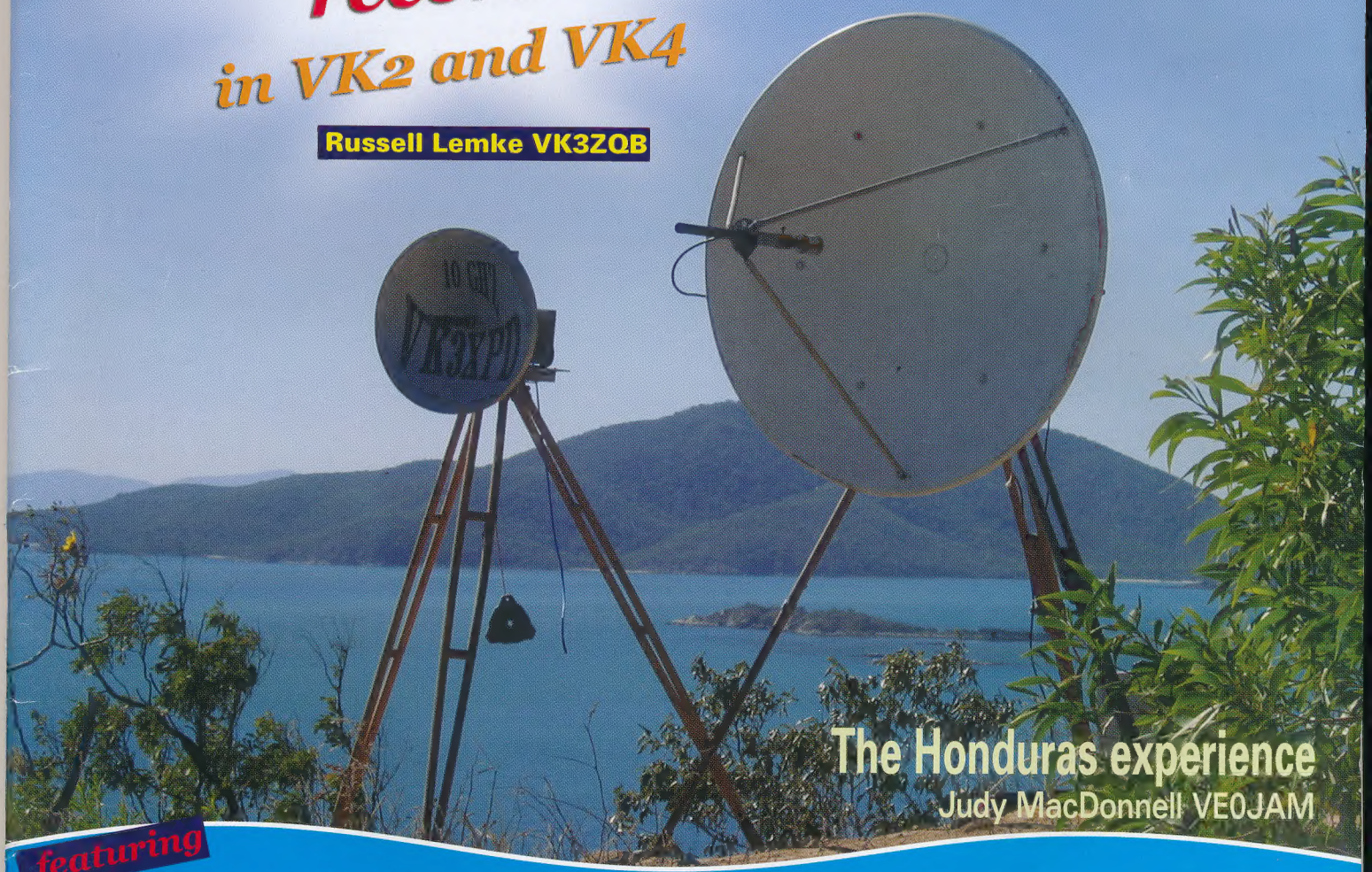
Russell Lemke VK3ZQB



The Honduras experience

Judy MacDonnell VE0JAM

featuring

- A compact, effective vertical antenna for 160 metres
  Drew Diamond VK3XU
- Some useful wire antennas for HF Pt 2
  Rob S Gurr VK5RG
- An experimenter's LF/MF receiver
  Dale Hughes VK2DSH
- A vertical antenna for 15, 17 & 20 metre
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Our Cover this month

Microwave equipment for record attempt at GloucesterPoint Hill. See page 29 for details

Contributions to Amateur Radio

Amateur Radio is a forum for WIA members' amateur radio experiments, experiences opinions and news. Manuscripts with drawings and or photos are always welcome and will be considered for publication. Articles on disc or email are especially welcome. The WIA cannot be responsible for loss or damage to any material. A pamphlet, How to write for Amateur Radio is available from the National Office on receipt of a stamped self-addressed envelope.

Back Issues

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Photostat copies

When back issues are no longer available, photocopies of articles are available to members at $2.50 each (plus an additional $2 for each additional issue in which the article appears).

Disclaimer

The opinions expressed in this publication do not necessarily reflect the official view of the WIA and the WIA cannot be held responsible for incorrect information published.

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A radiocommunication service for the purpose of self-training, intercommunication and technical investigation carried out by amateurs; that is, by duly authorised persons interested in radio technique solely with a personal aim and without pecuniary interest.

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International Amateur Radio Union

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Editorial comment

Colwyn Low VK5UE

Christmas greetings to all members and readers

This is larger issue than usual, as the next issue will not be out until February 2005. Aerials are the main topic in this issue. I hope you find some things to think about and some things to do in the articles and columns.

I note that the ***Spring VHF/UHF Field Day*** seems to have suffered from poor weather. I know I only went out for Saturday afternoon and made six contacts. I seem to have hit a bad patch, the FT-101 gave trouble in the CQ DX Contest and needs attention, the converted Philips 828 for 52 MHz was not completed, the PRM-8030 on 144 MHz seems to have lost output power, the FM-95 on 432 MHz suffered similarly and the 1296 MHz converter was "funny". I got a bit depressed at this point but Steve VK5AIM said his gear was working so we operated a joint station at St Kilda NW of Adelaide. Later I did some checking and found that RG58 is even lossier than I thought at VHF. 10 m is a 3 dB attenuator at 144 MHz and 7 dB at 432. Nothing wrong with the sets, just me. The FT-101 had a major overhaul thanks to John VK5MG and now is almost like new.

The ***Ross Hull VHF Contest*** starts after Christmas and ends on January 15th -16th weekend with the ***Summer VHF/ UHF Field Day***. This should give the VHF, UHF, and Microwave enthusiasts some serious challenges.

For the rest of us there should be plenty of opportunities in the long summer evenings to chat with old mates and find some new ones on the HF bands. There might even be the time to accept the challenge of major refurbishment of the station or building a piece of gear that has been wanted for several years.

I would like to think that the National WIA is now settling down and that amateurs are accepting this as the change "that had to happen" and that every effort is being made to ensure continuity of service at the local level. Let us all work together for the good of amateur radio in Australia in 2005.

I attended the wind up of the VK5/8 Division on Friday 19th November. The resolution to terminate the incorporation was passed unanimously by the 70 + members in attendance. Our President Michael Owen attended and in a short speech pointed out that Australia needs one voice to speak on behalf of all amateurs to the ACA and make representations to other levels of government as required. It also needed one voice to speak for Australian Amateurs in IARU. It also needs to have the resources and amateur volunteers to play our part in the IARU and to be part of the Australian delegation to the ITU. The one national Australian radio amateur radio institute should be able to plan our participation in and support of these activities. Keeping the hobby afloat requires major expenditure and it is provided by your subs. The WIA will now also pick up the cost of the repeater network previously funded by Divisions from their share of your subs.

I send you all Christmas Greetings from the Publications Committee of Amateur Radio magazine and we extend our best wishes for 2005 to you all.

In closing my personal Seasons Greetings and Best Wishes to all amateurs for a prosperous and happy 2005.

73 Colwyn, VK5UE, Editor AR

The President, Directors and office staff of the Wireless Institute of Australia

wish all members and readers of Amateur Radio

a very happy holiday season and a prosperous 2005

We will be back to serve you again in February

Michael Owen VK3KI

A better qualification system?

The most common criticism of the amateur examination system conducted by the WIA on behalf of the ACA is that it is too slow and cumbersome, that it takes too long for candidates to receive their results and that there is no automatic or timely indication to the candidate of the areas requiring further attention.

The system is really a series of steps, with invigilators nominated by clubs that have a group conducting exams, and markers who are separate from the group, with the papers being sent to the WIA office for marking more often than not without even a provisional mark being given to the candidate and with a strict requirement that each step is properly completed before the next step is taken. It doesn't take much for the necessary delay to be extended. If an invigilator forgets, for example, to sign the invigilator's declaration, then when the other documents are received the WIA office must chase him for the missing document and receive it before the next step is taken.

All of this is intended to provide a framework where by a strict separation of the roles of marker and the conduct of the examination and a strict adherence to a protocol, the process can be audited and opportunity for any improper assistance or other impropriety is greatly minimised.

The great advantage of the present system is that it enables clubs across the country to conduct examinations so that they can attract, train and test new amateurs in a local environment. The system is designed to take advantage of the many willing amateurs, most of whom have had no training as educationists, to provide a service in many regional and rural areas that would not otherwise be available.

The WIA has been reviewing the present system in the context of the work being undertaken in relation to the new syllabus for the Foundation Licence, as well as the new Standard and Advanced licences, the latter corresponding to the present unrestricted licence, but modified to meet the requirements of the European Conference of Postal and Telecommunications (CEPT) Recommendation T/R 61-02. This will enable Australian amateurs to operate in other countries participating in the Recommendation relying on their Australian amateur licence.

I would like to tell you where our thinking is currently at, and to invite our members to express their views on the proposals that we are currently examining.

I stress that this has not been put to the ACA at this stage, and so even if what is suggested is seen as a real solution to a real problem, there can be no guarantee that it will in the end be adopted.

Any assessment system must meet certain requirements, and have certain characteristics. For example:

Validity: the skills and knowledge to be checked should be assessed using a methodology that measures what is supposed to be checked. The method or procedure should be relevant to the way in which the application would occur in amateur radio.

Reliability: the assessment processes must have the capability to produce consistent results. This includes the need to provide sufficient evidence to make adequate decisions.

Credibility: processes and methodologies should ensure both internal and external acceptance. This includes meeting any safety or legal/regulatory requirements, which may relate to the skill or knowledge being assessed.

More practically, how can we devise a system or process whereby the candidate can know his result immediately?

Equally, if a practical assessment is required for the Foundation Licence, as suggested in the ACA Outcomes of the Review of Amateur Service Regulation, who is to make that practical assessment?

A competency-based training approach has been adopted in Australia, and is the basis of the nationally recognised qualifications based on the Australian Qualifications Framework. We are considering a system whereby WIA assessors are formally trained by a Registered Training Organisation (RTO), and accredited and registered by the WIA. Do we need to be satisfied that a registered assessor is a fit and proper person for the task? Perhaps registration could require submission of references and perhaps there could be other requirements.

Assessor registration would last for a period, say three or five years, after which time the assessor would be reviewed and where appropriate re-registered by the WIA. An audit procedure would be established and all assessors would be subject to audit.

These WIA registered assessors will be approved to assess all amateur examinations.

In addition to these assessors, there would be a small number of nominated special assessors. These would have a higher qualification, often people trained appropriately as teachers or the like, with their qualifications recognised for the purpose of their accreditation.

These nominated assessors would be able to administer special examinations. Special examinations are required, for example, for disabled people, for persons already a member of a group. Perhaps the nominated assessor could even administer practical assessment tests at a distance in prescribed circumstances. The special assessors would also audit other assessors.

The purpose of the accreditation system is not to train a "teacher". It is to train an individual to undertake a particular and narrowly defined task, that is, to assess the competency of a candidate for an amateur radio qualification. Of course, the assessor is

continued on page 28

WIA news

WIA Proposes Technical Interference Advisory Service

Recently the WIA Board considered a suggestion by Ron Bertrand, VK2DQ, suggesting the establishment of a Technical Interference Advisory Service for members.

The interference most likely to cause a member to seek help is interference to domestic appliances, such as radios, television, amplifiers and the like. Ron suggested that experienced volunteers around the country could provide the service.

The Board thought that the suggestion to have considerable merit.

The Board considered that such a service would need to be carefully structured, as it would be very easy for the volunteers to become involved in disputes, which was not intended. Such a service could not be involved in dispute resolution, nor interference caused by one amateur to another, or indeed any aspects of individual behaviour, whether a vendetta by one neighbour against another or conflict between amateurs.

Glenn Dunstan, VK4DU has agreed to be the director responsible for the project, and the Board has appointed Gilbert Hughes, VK1GH, as National Coordinator.

Ernie Hocking resigns as WIA Director

WIA Director and Vice President, Ernie Hocking VK1LK has advised the WIA Board of his resignation as a director of the WIA and therefore as Vice President.

Ernie has told the board that his ongoing heavy work commitment means that he is unable to contribute as actively to the WIA as he would like, and that given the importance of establishing a fully functional national body, he would prefer to stand aside to allow someone else to replace him.

He told the board "I can assure you of my continued support for the Institute and its current efforts to establish a truly national peak body to represent the best interests of amateur radio in Australia."

The board has accepted Ernie's resignation "with regret and gratitude for his extraordinary contribution to the WIA".

Michael Owen, VK3KI, WIA President paid tribute to Ernie's vision and contribution to the restructuring of the WIA, and said that the WIA cannot afford to lose his experience.

Ernie has accepted the position of Special Advisor to the Board.

Board appoints VK3KRB as new director

The Constitution of the WIA requires the Board to fill the vacancy created when a director resigns.

The Board has appointed Robert Broomhead, VK3KRB, a director of the WIA to fill the vacancy created by the resignation of Ernie Hocking as a director for the remainder of the term of Ernie's appointment.

Robert's voice is well known to many amateurs, as he has been a member of the WIA news presentation team. He has been deeply involved in his local club, the Eastern and Mountain District Radio Club, and is currently its Vice President.

He is yet another member of the board with a significant club background.

The Amateur Radio 2005 Events Calendar

The WIA has placed an Events Calendar on the national website (www.wia.org.au) so that when a club is planning an event, or a contest, you know in advance what else is going on.

You can find it by clicking on Member Services, and then, Coming Events.

Ted Thrift, VK2ARA, director with special responsibility for clubs, says that if your club wants to be part of the 2005 Events Calendar and make sure that your club gets a good shot at the action, send your 2005 Events Calendar to him at tthrift@iprimus.com.au.

WIA Summary of the FCC Report and Order on Access BPL

The US Federal Communications Commission (FCC) has published its full Report and Order on Access to BPL.

The FCC says that it wishes to develop policies encouraging the implementation of BPL bringing an end to the broadband duopoly of cable modem and DSL service, while managing the technologies' interference potential.

WIA director with special responsibility for BPL, Phil Wait, VK2DKN, has placed on the WIA National website a summary of the extensive FCC material.

Victoria Club Forum Report

The WIA is moving ahead even faster following the Victoria Clubs Forum held on Saturday 23 October and attended by 15 radio clubs.

Barry Robinson, VK3JBR, who chaired the meeting organised by the WIA Victorian Advisory Committee and Amateur Radio Victoria said that the Forum lived up to its expectations in providing an excellent networking opportunity for radio club officials.

In addressing the gathering, WIA National President Michael Owen, VK3KI, described the WIA as being in a period of evolution, with a good structure in place, and seeking feedback from radio clubs on a range of matters.

A spirited discussion took place on possible criteria for club affiliation with the WIA.

All clubs were keenly interested in learning about the Foundation Licence that is due to be introduced next year. The WIA has produced a draft syllabus.

VK3KI said that the Board is now considering how best to conduct the practical assessment element of the Foundation Licence. This may require examiners undergoing an accreditation course.

In concluding the Forum VK3KI expressed his appreciation to the organisers, and praised the quality feed back he had received from the club delegates.

UK Amateurs Gain 7.1 - 7.2 MHz

The Radio Society of Great Britain announced on October 29 that all necessary procedures required for early

continued on page 26

A compact, effective vertical antenna for 160 metres

Part 1

Drew Diamond VK3XU

Our lowest band, 160 metres ("Top Band" - 1.800 to 1.875 MHz) continues to attract new enthusiasts. The amateur with a reasonably tall mast, or tower, can usually erect a wire antenna of sufficient height and length to put out a good signal. But limited space and height is a problem for some of us, so what can we do?

Vertically polarised, ground-wave propagation is almost universally used for cross-town working, and the usual method of creating such a wave is with a vertical antenna of some kind. At night, a vertical antenna is also good for long-distance work.

The impedance measured at the base of a resonant ¼-wave radiator with respect to a good ground system (Figure 1) is of the order of 30 or 36 ohms (Reference 1), where most of that 36 ohms is "radiation" resistance (Rrad), which represents that part of the antenna load that does useful work as radiation. In series with Rrad is the loss resistance Rloss (Figure 2), usually represented by a lump sum of all those effective resistances that waste power as heat, such as earth/ground resistance, conductor resistance, dielectric losses and losses caused by the proximity of poorly conducting bodies such as trees and buildings.

A radiator smaller than ¼ wavelength (Figure 3) will exhibit a rapidly decreasing Rrad, as it is shortened. At 0.1 wavelength (16 m physical), Rrad will be about 9 ohms. If Rloss is also 9 ohms, then half the power delivered to the system will be wasted, even if Rrad + Rloss is efficiently matched (with a suitable network) to our transmission line. Hence, for any radiator worked against ground, best efficiency is obtained when all resistance losses are kept to a minimum (Reference 1). In series with Rrad and Rloss is a reactive (X) component of the impedance. Being shorter than ¼ wave, this reactance will be capacitive, usually expressed as -jX, and of rapidly increasing reactive value as the radiator is shortened (Figure 2).

A quarter-wave vertical for 1.8 MHz would be about 40 m tall, and probably well beyond the realm of most urban amateurs. In medium-wave commercial broadcasting, for instance, the optimum radiator is considered to be a $^5/_8$th wave vertical with a multitude of buried ground radials (References 2 and 3), or, at the very least, a quarter-wave with as many ground radials as economically possible. However, by "loading" the radiator, it is easily possible for the amateur to construct a reasonably efficient vertical antenna which is considerably shorter than a physical quarter-wave.

There are two conventional methods of loading a radiator, top-loading by capacitance (or "capacity-hat" loading, Figure 4), and lumped inductive loading (Figure 5). Professional vertical antennas for VLF and LF typically use capacity loading in order to increase the radiation resistance of a physically short antenna (Reference 4). A vertical antenna for 1.8 MHz may also be capacity-hat loaded (Reference 5). However, to work efficiently the system still needs to be physically rather large.

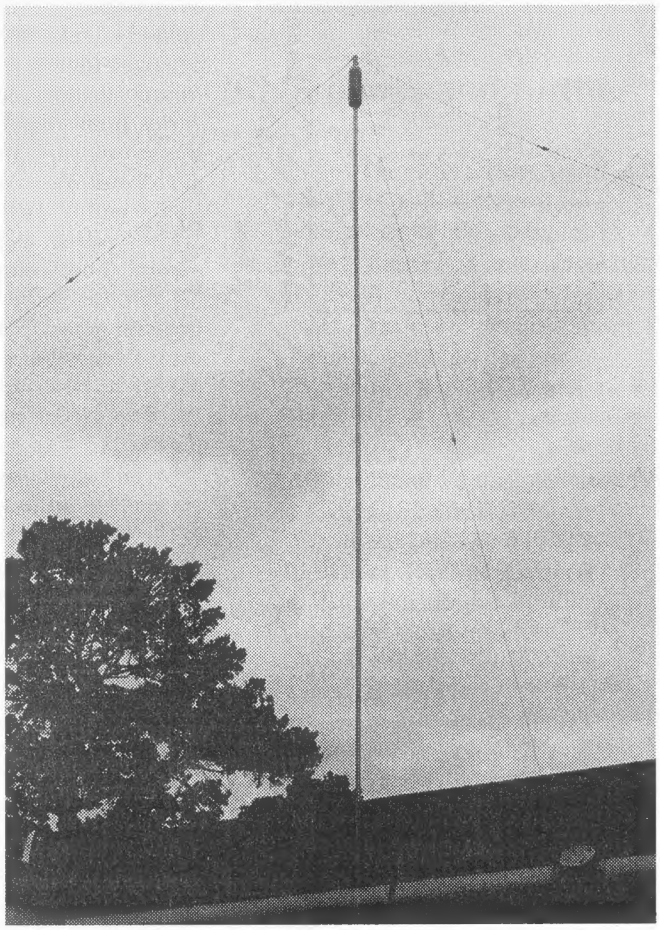
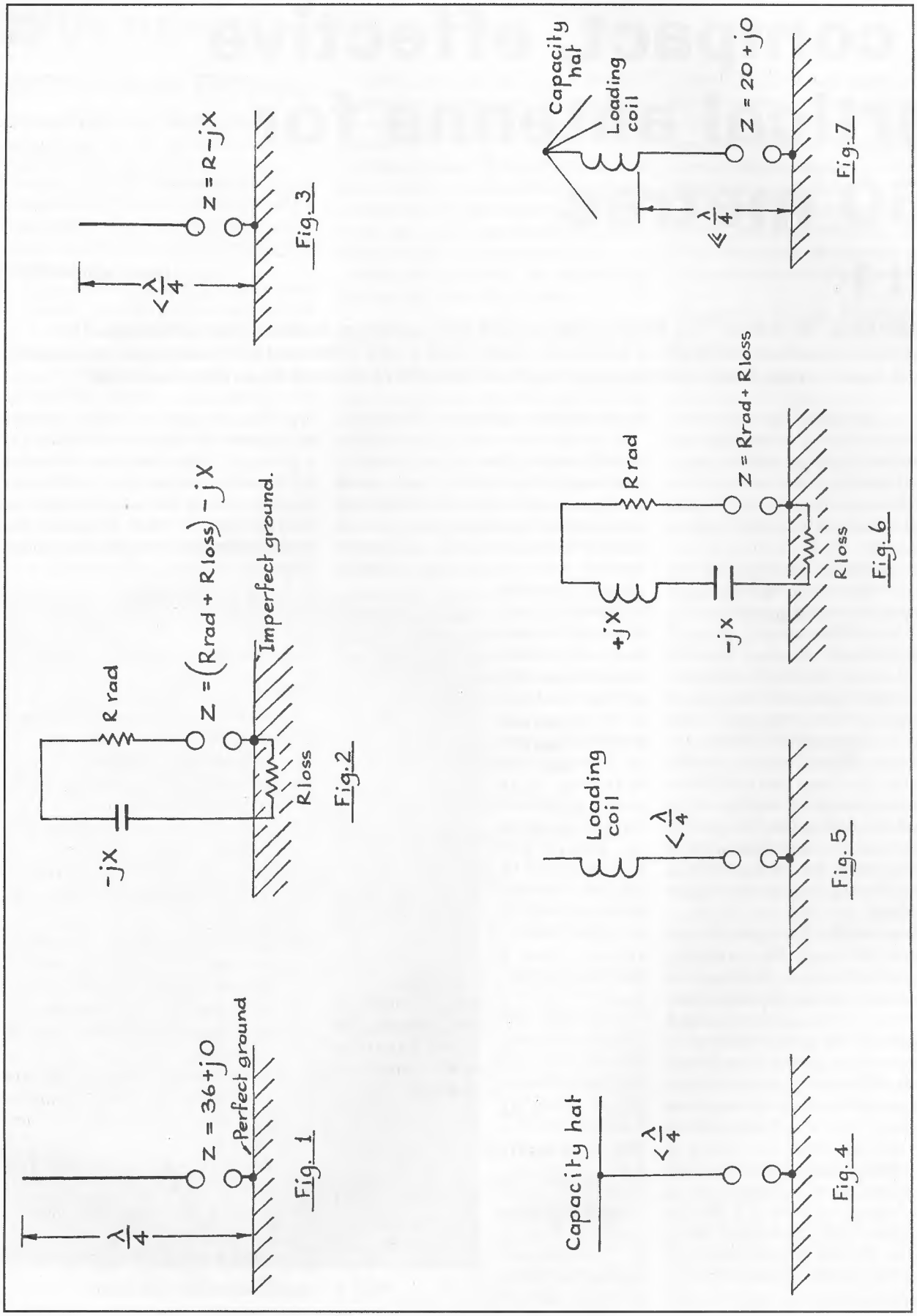


Photo 1 – Loaded vertical for 160 metres


Z = 36+j0
Perfect ground
λ/4
Fig. 1
-jX
R rad
Z = (Rrad + Rloss) - jX
Imperfect ground.
Rloss
Fig. 2
λ/4
Z = R-jX
Fig. 3
Capacity hat
λ/4
Fig. 4
Loading coil
λ/4
Fig. 5
+jX
-jX
R rad
Z = Rrad + Rloss
Rloss
Fig. 6
Capacity hat
Loading coil
≪ λ/4
Z = 20 + j0
Fig. 7

Figs 1 – 7

Because a short antenna is capacitively reactive, we must add an equal amount of inductive reactance (+jX) to obtain a net reactance of zero (+jX -jX, leaving just Rrad plus Rloss, Figure 6). So, a lumped inductance in the form of a coil or helix may be inserted at some appropriate point in the radiator.

The positioning of the coil is problematic. Even the best made coil will have some loss. When all else is equal, a higher inductance (more turns) will incur a higher I squared R loss. When the coil is at the base, the current through the coil is high, but the inductance required is moderate. As the coil is moved up the radiator, the current falls, but the amount of inductance required increases. It has been found empirically that a position about half-way (or "centre loading") provides a good compromise between coil inductance and coil loss (Reference 6).

If one accepts the popular notion that the strength of the far field is proportional to current flow in the radiator, when placed conveniently at the base, current distribution in the radiator above the coil is poor. Placing the coil further up the radiator improves current distribution (References 6 and 7), but then the need for a gap in the radiator and the mechanical problems of accommodating and protecting the coil (from the weather) may seem difficult.

A good and workable compromise is to adopt a combination of both capacity and inductive loading (Figure 7). By using part of the necessary top guy wires as a capacity hat, and locating the loading coil a short distance below the hat, we obtain a relatively small, practicable antenna (Photo 1) capable of surprisingly good performance.

The goal was to make a vertical antenna using purchasable materials, capable of providing acceptable performance on 1.8 MHz. All electrical joints and connections are kept to a minimum, which prescribes a single length of tube for the vertical part. A height of 6.5 m above the roof should not (it is hoped) cause objectionable visual impact.

A $^{1}/_{16}$th size experimental model of the planned antenna was made for 29 MHz which, after being optimised, and then scaled up in size for 1.8 MHz, allowed use of the 10 x 10 m metal decking roof upon the "granny flat" of our house as a "ground-plane". A stock 6.5 m length of 32 mm diameter aluminium tube forms the vertical component, making the height to the capacity hat apex only about 10 m above ground level.

Much experimental work has been done in arriving at a satisfactory loading coil. Using ordinary white UPVC water pipe as the coil form, various coil configurations were tested, relying greatly on distant reception reports. One very interesting finding, which confirms several statements about the coil's form (eg Reference 8), is that a spaced winding is far superior to close-winding. This observation, and why it should be so, has caused great discussion.

The loaded vertical antenna is quite conventional in operation. The H (magnetic) component is produced mainly by radio-frequency current travelling along the vertical conductor (tube), and the electric (E) field is produced by the capacity hat situated above the vertical. These two fields combine in the near-field to produce a radiated electro-magnetic field.

Many antenna workers declare that the H-field of a lumped coil contributes significantly to the far field. I cannot agree with this assertion, because the H-field produced by the coil is at right-angles to that created by the main vertical current-carrying conductor (right-hand screw rule, see Reference 9). Furthermore, if the coil's field were to contribute (to the far field), then the coil's winding would have to be connected in the correct "phase". No such stipulation is known in this regard.

Back to the coil. The measured capacitance between adjacent close-wound turns (for my coil) is 18 pF, whereas the capacity between turns spaced 4 mm is just 0.4 pF, which represents a 45-fold reduction. The inter-winding capacitances, although they are effectively in series across the length of the coil, ultimately appear in shunt with the capacity hat, thereby reducing the intensity of the electric field. By spacing the turns, we reduce this unwanted capacitance, and its shunting effect, to a very small value.

Performance

My "reference" antenna is a $^{3}/_{8}$th-wave inverted-L, 10 m high at the shack end rising to about 15 m at the far end, which works rather well both for local cross-town and long-distance work. By switching between the L and the loaded vertical (always remembering to disconnect the other antenna to prevent any coupling effects), signal strength reports were obtained from local (around Melbourne), interstate and DX operators.

Applying AA6GL's vertical antenna software (Reference 10), for an estimated 10 ohms ground loss the antenna has a computed radiation efficiency of about 30 %. The transmitted signal from the vertical is generally about 6 dB better than the L for local ground-wave work. Reports from interstate and the USA were more circumspect due to fading, but certainly the vertical was generally about as good as the inverted-L.

Measured feed-point impedance at the base is 20 ohms (SWR 2.5) at the resonant frequency of 1.840 MHz. At this frequency an SWR of 2.5 is not excessive in good RG-8 coax cable, where the necessary coupler/matching network (described in a forthcoming essay) may therefore be conveniently located at the transmitter end of the coax line. The vertical may thus be effectively operated over the greater portion of the band.

Construction details are given in Part 2.

References and further reading

1. *Radio Communication Handbook*; 7th edition RSGB, pp 13.54 - 58 (and previous editions).
2. *Radio 2; Australian Post Office,* 1951 (Paper 2).
3. *Radio Engineers' Handbook;* F Terman, 1943, pp 843 - 849.
4. *The Amateur Radio Vertical Antenna Handbook;* P Lee, CQ Technical, pp 22-31.
5. "A Broadband Vertical Antenna for 1.8 MHz"; S Hunt, G3TXQ, *RadCom* November 1987, pp 830-832.
6. *All About Vertical Antennas;* Orr and Cowan, Radio Publications, pp 69-71.
7. "Home Station Antenna for 160 Metres Part 2" (of 4); J Adcock VK3ACA, *Amateur Radio*, June 1971, pp 3-7.
8. *The ARRL Antenna Book*; 17th edition, pp 4.19 - 20.
9. *Electrical Technology*; E Hughes; 7th edition, Prentice-Hall, pp131, 132.
10. *Antenna Software* by AA6GL; recent ARRL Handbooks..

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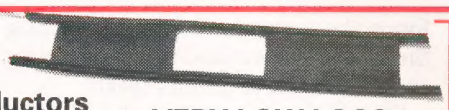
450 Ohm Ladder Line



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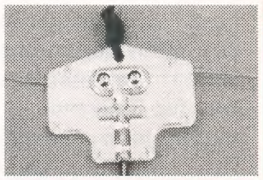

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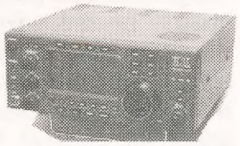

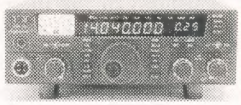

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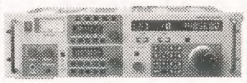

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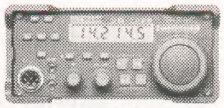

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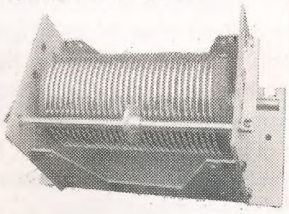

Antenna Couplers/Tuners

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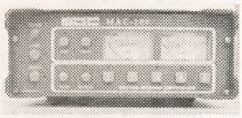
5 Position Antenna



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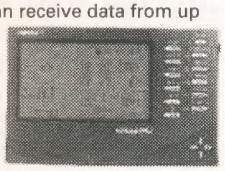

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Some useful wire antennas for HF – Part 2

Rob S Gurr VK5RG continues sharing his knowledge of wire antennas with us.

(Originally published in Amateur Radio Volume 64, No 4, April 1996)

G5RV

This antenna is one of the most popular in use on HF. It first came to amateur attention in 1935, being a design for a multi-directional radiator for 14 MHz. In the late 1940s, G5RV promoted its use as a multiband antenna, fed with a matching stub and a 75 ohm coaxial cable. The antenna on 14 MHz is 1.5 wavelengths long and, with six useful lobes, was much better than a dipole (Fig 9). It followed that the SWR was low on 14 MHz and on some other bands popular at the time, and its use as a universal antenna grew, particularly as any mismatch on these bands could be taken up by the pi network output stages in the valve transmitters in use in those days.

On 3.5 MHz it became a shortened dipole, and on 7 MHz the bidirectional characteristics of a full size dipole were evident. However, with the introduction of solid state equipment with a fixed 50 ohm output impedance, it became necessary to use an antenna coupler with the antenna, and subsequently the later articles show the antenna in the open wire configuration. The directional properties on the various bands were accepted without question, but many experimenters testing the antenna found that often the results obtained were not as good as a previously used dipole. This is common with a lot of short period tests of long wire antennas, where the stations being contacted are located in a deep "null" (Fig 9) giving poor results. However, a station on a bearing only a few degrees away may be of good strength (this aspect of all antennas must be kept in mind when conducting such tests).

The antenna dimensions are 15.54 m each side of centre, and the matching section of open wire line is 10.36 m. However, any length of line should be suitable, if correctly matched with an ATU.

Terminated Vee Beam

Long wire antennas exhibit considerable gain at little expense (compared to some commercial antennas)(see Fig 12). Regrettably, the gain in some cases is spread over four major "lobes" as well as some smaller lobes. Apart from having gain, there are, unfortunately, directions in between the main lobes where there is very little radiation, or "nulls". This latter property, mentioned before, explains why sometimes an unsuspecting amateur may build a long wire antenna and find it is ineffective, the only stations on the air during his trials probably being in the direction of these "nulls".

The angles of major radiation and the "nulls" can be determined from prepared charts and a combination of "long wires" made to amalgamate these lobes into a useful directional "beam". Two popular antennas are the "Vee Beam" and the "Rhombic" which, in their standard form, are bidirectional, but when "terminated" become unidirectional in the direction of the termination.

The rhombic is a little large for suburban backyards but, where space is available, it is a high grade antenna.

The "Vee" beam also requires a large area. However, in case a suitable space is available, or there are some friendly neighbours, I will describe a terminated "Vee Beam" with special features.

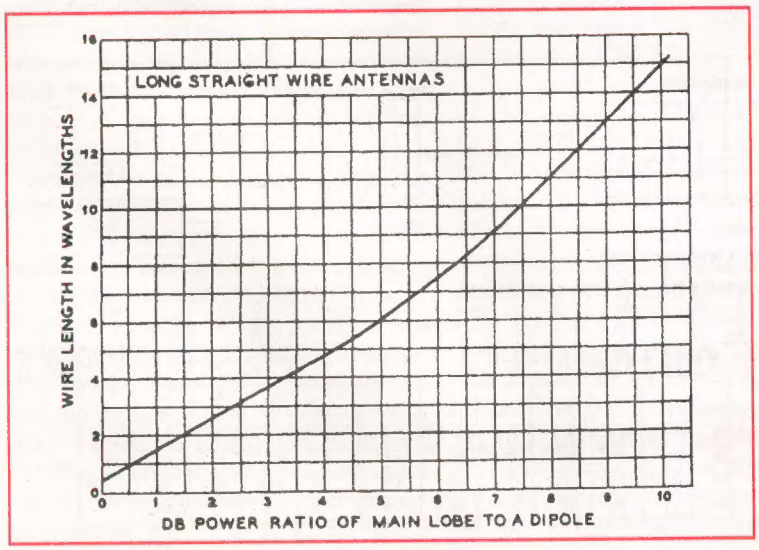


Fig 12 – Directive gain of long wire antenna.
(Reprinted from the Radio Handbook, 21st edition, page 28-3)

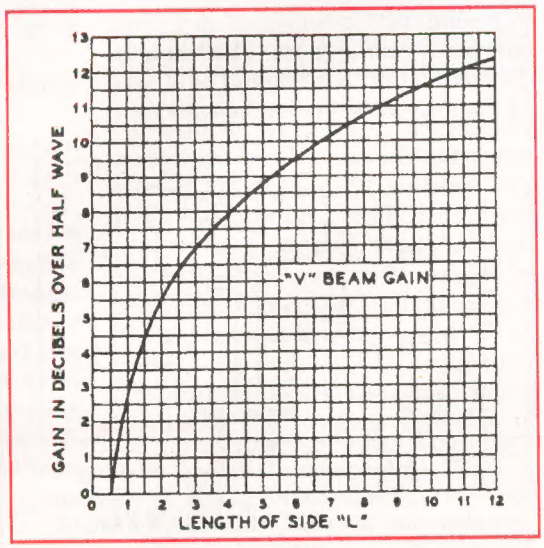


Fig 13 – Directive gain of a V beam.
(Reprinted from the Radio Handbook, 21st edition, page 28-5)

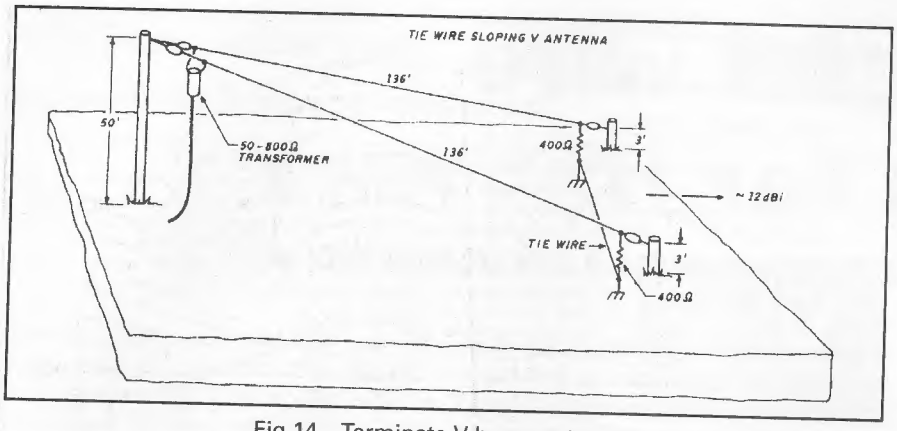


Fig 14 – Terminate V beam antenna.
(Reprinted from Ham Radio, May 1990, page 49)

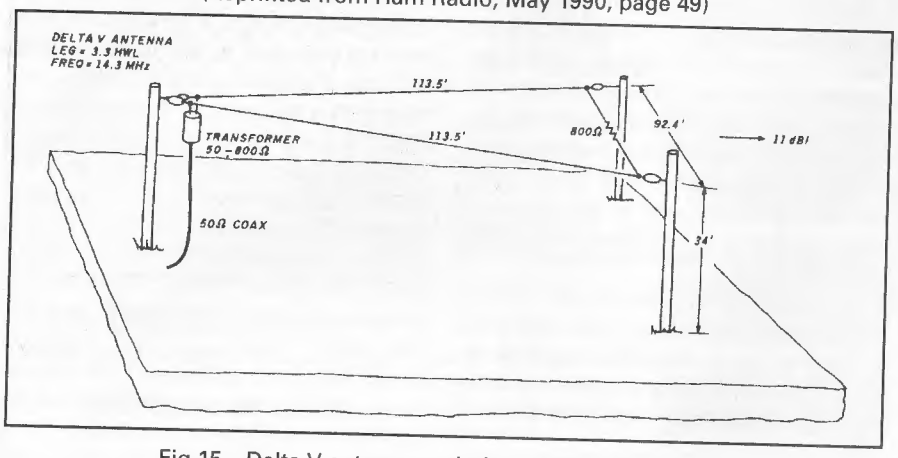


Fig 15 – Delta V antenna optimised for the 20 m band.
(Reprinted from Ham Radio, May 1990, page 52)

Leg length (half wave-length)	Delta gain (dBi)	V gain (dBi)	Comments
1.7	9.3	9.4	Compact antennas
2.1	9.9	9.9	Compact antennas
3.3	12.4	11.0	Best Delta trade-off
6.0	12.0	12.8	
7.5	12.8	13.6	
8.7	12.9	13.5	
10.0	13.1	14.9	Highest gain size

Fig 16 – Table 2
"Magic" leg lengths in half waves for Delta and V antennas. (Other delta dimensions are not recommended.)
(Reprinted from Ham Radio, May 1990, page 51)

The Vee beam

The lobes of two long wires may be combined into forming a Vee Beam, with gain, as shown in Fig 13. The resultant bidirectional pattern may be made unidirectional by terminating each distant end with a 400 ohm resistor to ground, with a benefit of up to 3 dB additional gain (Fig 14). The height of the apex of the "Vee" should be at least 10 metres, whilst that at the ends need only be adequate to clear pedestrians, and animals if on a farm paddock.

The slope of the wires gives further enhancement to the unidirectional properties. When the terminating resistors are returned to ground, the suitability of the ground conductivity is often suspect, to the extent some constructors put in a ground wire immediately below the antenna wires. A now popular method of avoiding this ground return problem is to connect the two wires together, across the base of the Vee, and connect them together with a termination resistor of double the value (ie 800 ohms).

Fig 15 shows the dimensions pictorially, and a chart showing potential gain is shown in Fig 16. As is evident, there is every reason to expect good results from such an antenna.

The W8JK antenna

First published in the late 1930s, an article on end-fire antenna arrays, by Dr John Kraus in the USA, presented to the engineering world an interesting multiband gain antenna suitable for

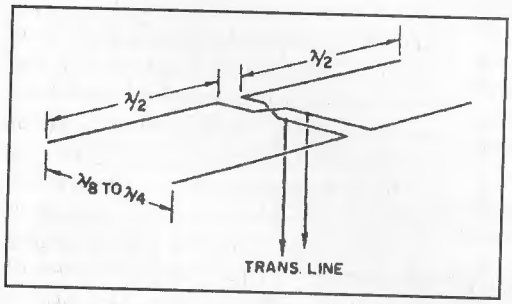
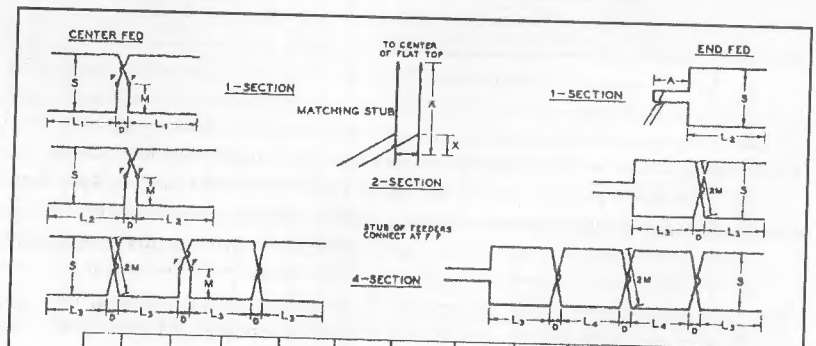


Fig 17 – A four-element array combining collinear broadside elements and parallel end-fire elements, popularly known as the W8JK array.
(Reprinted from the ARRL Antenna Book, 15th Edition, page 8-37)



Band	S	L_1	L_2	L_3	L_4	M	D	A (¼)	A (½)	A (¾)	X
40	17'	33'6"	59'	51'8"	43'1"	8'8"	4'	26'	59'	94'	4'
20	8'8"	17'	30'	26'4"	22'	4'9"	2'	13'	30'	48'	2'
15	7'10"	12'8"	22'6"	18'3"	15'	4'0"	1'8"	10'6"	22'	36'	1'6"
10	5'2"	8'6"	15'	12'7"	10'	2'8"	1'6"	7'	15'	24'	1'

Fig 18 – W8JK array design data.
(Reprinted from the Radio Handbook, 21st edition, page 28-16)